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Study of Water Body to Analyze its Impact on Fish Fauna

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Abstract—*The habitats of fish are being affected by the change in water quality parameters due to increased pollution. As consumption of fish forms an important part of our basic food diet, an effect on them has a direct impact on the entire food chain starting from the smaller organism to the multicellular organisms. So, there is a huge need that the quality of available water resources is being monitored. This paper presents a study on the quality of water by measuring parameters such as temperature, pH, and turbidity of a water body. A microcontroller based system is designed which analyses these three parameters and help us indirectly determine how the fish fauna is being effected.*

1. INTRODUCTION

In order to determine the water quality various kinds of parameters come into picture. Parameters can be biological, chemical, physical or thermal all depending upon the type of application or the way in which the water quality parameter is to be used in a system. For example, parameters determining the water quality to irrigate a crop are totally different from the parameters that determine the ones used for any industrial application. With the ever increasing population of mankind, water pollution plays a very crucial role that hampers the entire ecosystem of nature starting from single celled to multicellular organisms. Water quality is effected by both point and non point sources. Point sources are the ones that can be traced back to a single source e.g. drain, ditch, pipe etc. Non point sources are the ones that diffuse into the landscape of the surroundings of the nearby water bodies due to both natural and manmade activities [1].

Water quality is degrading day by day with the ever increasing population polluting the water bodies found everywhere around the globe. This lack of awareness among the masses has a direct impact on the fish fauna of a given water body. Since human beings are a direct consumer of fresh and marine water products, an impact of them has an indirect influence on the overall well-being of human beings. Thus comes the need for water quality monitoring where few basic parameters can be monitored on a regular basis to conclude whether a given water body is suitable for fishery, aquaculture or any form of aquatic life sustenance. In case a water body is found unsuitable for the survival of aquatic life then the user or client or governing organization in charge of a given water body can take the necessary steps to avoid any further damage to the water quality of a given water body.

This paper mainly focuses on monitoring a small water body (e.g.: a pond/fishery grounds) which is used for fish culture and fish breeding applications. The aim is to establish a system by using temperature sensor DS18B20, pH sensor SEN0161 and turbidity sensor SEN0189 which will be continuously monitoring the parameters (temperature, pH, turbidity) of the water body. The readings will then be analyzed in order to determine whether the water body is suitable for fish breeding or not. It is a continuous study of a particular water body and obtaining a set of readings for different parameters and then finally from those obtained readings a conclusion can be drawn about that particular water body. This conclusion will help in determining whether the water body is suitable for fish breeding or not.

2. BACKGROUND

2.1 Main parameters considered for the system are as follows:

2.1.1. Temperature. Temperature plays a very important role on the overall growth and sustenance of living organisms in a water body. Even if the temperature is above or below a threshold value the aquatic organisms may not survive under the given conditions. Less is the temperature greater is the Dissolved Oxygen while more is the temperature less is the Dissolved Oxygen. Many toxic (cyanide, phenol and xylene) substances become more lethal when present at high temperature. Many a times with sudden increase in temperature the cold water fishes may leave the given stream site and warm water fishes may take their position. Thus the overall mortality rate may remain the same but the characteristics of the water body in terms of the type of fish fauna available may change.

Table 1. Temperature vs. Dissolved Oxygen relationship [2]

Temperature(Degree Celsius)	Oxygen Solubility(mg/L)
0	14.6
5	12.8
10	11.3
15	10.2
20	9.2
25	8.6
100	0

Table 1 represents the readings observed by using the Winkler's Method to find the concentration of Dissolved Oxygen in Fresh Water. The above table gives us an important relationship between Dissolved oxygen and temperature as Dissolved oxygen too is an important parameter which shows us how healthy the water is assuming less pollution and more productivity for the survival of fish fauna.

2.1.2. pH. pH stands for "potential of hydrogen" and is a measure of the hydrogen ion concentration of a given sample/solution[3]. Solutions with a high concentration of hydrogen ions have a low pH while solutions with low concentrations of H+ ions have a high pH. pH is one of the most common parameters to test the water quality of a given sample or body of water. Different kinds of fishes are adapted to different ranges of pH values starting from egg laying, egg hatching and even for mating. Thus a slight change in pH can affect the overall sustenance of a given fish species. Various factors affect the pH of a watershed like the manmade and industrial activities in and around the water body, natural phenomena's like acid rain etc.

2.1.3. Turbidity. Turbidity is a measure of cloudiness or clarity of water. Cloudiness can be caused by the suspended clay/dust particles present in the water or may be due to presence of other microscopic plants and organisms present in the water body. Moderate amount is desirable since it shows a healthy growth of aquatic organisms in the water body while more than the prescribed value is always undesirable as it indicates higher chances of presence of other pathogenic viruses and bacteria's and induces poor health to both fishes as well as for humans. Nephelometers measure the intensity of light scattered by the suspended particles present in water. Turbidity is measured in Nephelometric Turbidity Unit (NTU) or Jackson Turbidity Unit (JTU). The turbidity in drinking water is less than 5 NTU as per the guideline given by World Health Organization (WHO). Turbidity more than 5NTU OR 5JTU may be unsuitable for human consumption.

Table 2: Optimum range of water-quality criteria for different water quality determining parameters [4]

Sr. No.	Parameter	Acceptable Range	Desirable Range	Stress
1	Temperature(in Celsius)	15-35	20-30	<12,>35
2	Turbidity(cm)		30-80	<12,>80
3	Water color	Pale to light green	Light green to light brown	Clear water, Dark Green& Brown
4	Dissolved Oxygen(mg/L)	3-5	5	<5,>8>
5	BOD(mg/L)	3-6	1-2	>10
6	CO_2(mg/L)	0-10	<5,5-8	>12
7	pH	7-9.5	6.5-9	<4,>11
8	Alkalinity(mg/L)	50-200	25-100	<20,>300
9	Hardness(mg/L)	>20	75-100	<20,>300
10	Calcium(mg/L)	4-160	25-100	<10,>250
11	Ammonia(mg/L)	0-0.05	0-<0.025	>0.3
12	Nitrite(mg/L)	0.02-2	<0.02	>0.2
13	Nitrate(mg/L)	0-100	0.1-4.5	>100,<0.01
14	Phosphorus(mg/L)	0.03-2	0.01-3	>3
15	H_2S(mg/L)	0-0.02	0.002	Any Detectable Level
16	Primary Productivity(C/L/D)	1-15	1.6-9.14	<1.6,>20.3
17	Plankton(No./L)	2000-6000	3000-4500	<3000,>7000

The main Sensors used in this system are as follows:

2.2 Temperature Sensor

Figure 1: DS18B20 [6]

The following are the main features of DS18B20 Digital Thermometer:

- It uses 1-Wire Interface that requires only one wire for data transfer.
- It has programmable Resolution of 9-bit to 12-bit.
- It is designed to measure temperatures in the range of -55 ^{0}C to +125 ^{0}C.
- It is available in different packages like TO-92, 8-Pin SO and 8-Pin µSOP. [5]

2.3 pH Sensor

Figure 2. SEN0161 [7]

- The module Power is 5.00V.
- The circuit board size is 43mm×32mm.
- The pH Measuring Range is 0-14.
- The accuracy of this meter is ± 0.1pH.
- The response time is ≤ 1min. [8]

The basic principle is that pH sensitive element is a glass ball fused with the end of a glass tube which forms the electrode. The electrode is filled with KCl (potassium chloride) which is having neutral value at pH 7 and contains a AgCl (silver chloride) wire that forms electrical connection. The reference system is located at outer glass tube which contains the same solution of KCl and another silver chloride wire. The inner glass tube forms the measuring system and the outer glass tube forms the reference system. The potential difference between these two wire (i.e. the measuring wire n reference wire). The meter then translates the voltage difference into pH and displays it on the screen.

2.4 Turbidity Sensor

Figure 3. SEN0189 [9]

Turbidity is the cloudiness of a liquid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.

The turbidity sensor detects water quality by measuring the different levels of turbidity. It uses light to detect suspended particles in liquid by measuring the light transmittance, which changes with the change in total suspended solids (TSS) in water. As the TTS in liquid increases, the liquid turbidity level also increases. This sensor provides analog output modes. [9]

2.5 Arduino UNO Board

It is a microcontroller board based on ATMEGA328.

Few important features are:

Figure 4. Arduino UNO Board [11]

- It has 14 digital input/output pins.
- It has 6 analog inputs.
- It has a 16 MHz ceramic resonator.
- It has a USB connection.
- It has a power jack.
- It has a reset button.
- It has an inbuilt ADC.[10]

3. BLOCK DIAGRAM

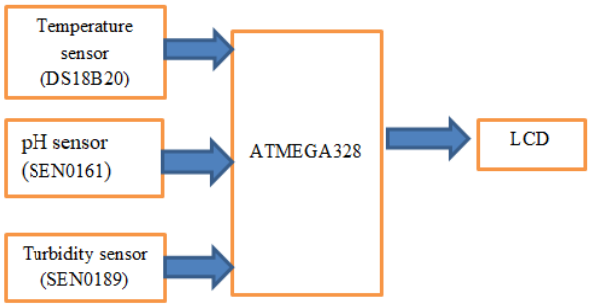

Figure 4. Block Diagram of the Water Quality Monitoring System.

As seen in the block diagram Fig 4, the temperature sensor (DS18B20) which is a digital sensor is connected to the digital pin of Arduino Uno Board. The pH sensor (SEN0161) and the turbidity sensor (SEN0189) both are analog sensors and are connected to the analog ADC pins of Arduino.The connection is so because the Temperature sensor is a digital sensor which will give us the temperature values directly without any conversion needed and thus we will not require use of any ADC in this case. While for the Turbidity and pH Sensors are analog hence we would need them to be connected to the analog pins of Arduino so that the analog voltage values can be converted to their respective Turbidity and pH readings.

The program code is then run in Arduino IDE so that these three sensors can process the program in the microcontroller present(i.e. ATMEGA 328) and can produce readings for the given water sample in terms of temperature ,pH and turbidity and show the values onto the LCD . Therefore the user can observe the values produced on the LCD.

4. RESULTS AND DISCUSSION

Figure 5. Nearby pond where the Water quality monitoring sytem is used.

As seen in Fig 5 it shows the practical pond site near Maligaon Rest Camp Kalibari,Guwahati, Assam where the readings have been taken on a regular basis.

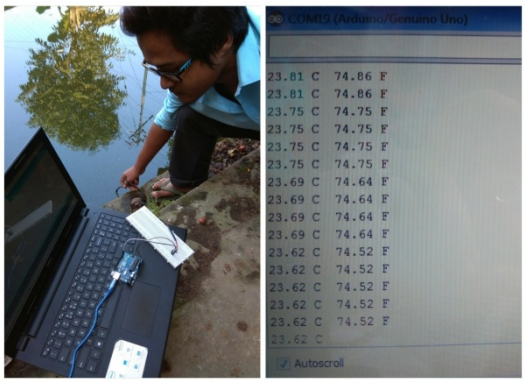

Figure 6. On site temperature measurement of water body using Temperature Sensor DS18B20.

The above Fig 6 shows readings as taken using the Temperature sensor (DS18B20) when dipped in the pond water. As soon as the program code was run using the Arduino the Temperature Sensor started producing the corresponding temperature in both Celsius and Fahrenheit scale on the Display of the laptop.

Table 3 shows the temperature readings of the Pond taken on a regular 1 hour interval on a particular day. It is observed that the temperature reaches the maximum value during the afternoon at around 1:00 pm and

Table 3. Readings observed for a particular day using DS18B20 Temperature sensor.

Time of the day	Temp(in degree Celsius)	Temp(in degree Fahrenheit)
12 am	26.23□	79.21
1 pm	26.91□	80.43
2 pm	24.56□	76.19
3 pm	23.69□	74.64
4 pm	23.33□	73.99
5 pm	22.17□	71.91
6 pm	21.88□	71.38

gradually goes on decreasing as the sun starts to set and move into the supper time. Thus at around 5:00-6:00 pm the temperature starts to reach a minimum value out of the entire set of values observed. The temperature may even fall more as the night time approaches.

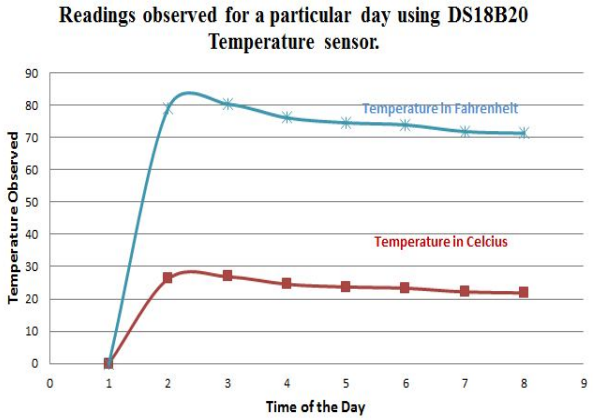

Figure 6. Corresponding graph plotted for the temperature observed using Temperature sensor DS18B20.

As seen in the above Fig 6 it is observed that the same trend is being followed as discussed for the previous table where the temperature reaches the maximum during the noon time and gradually goes on decreasing as the sun slowly starts to set.

Table 4: Readings of samples taken for three different types of water samples.

Samples taken	Sample 1 (Muddy water)	Sample 2 (Drinking Water)	Sample 3 (Mixture of mud, soap, oil)
pH	6.2	7.5	8.8
Turbidity(In NTU)	223	0.54	50

Table 4 shows readings for three different samples of water to show that all the three sensors are working properly and are producing satisfactory results.

For this purpose 3 different samples were taken. The first sample was pure muddy water and thus the turbidity comes

out to be quite high (i.e. 223NTU) as expected since it has very high concentration of dissolved impurities in it. The pH (i.e. 6.2) is also satisfactory since it is not pure drinking water (whose pH is 7 ideally) and thus a pH of 6.2 in this case is observed which is not objectionable. For the second sample plain bottle water was taken and thus it had very less turbidity (i.e. 0.54NTU) as expected while the pH comes out to be 7.5 which is also acceptable. The last sample is a mixture of mud, soap and a few drops of oil. This sample was made with an intention to see if the pH sensor can sense the alkaline nature of the liquid because of the presence of soap in it and also if the turbidity sensor is working properly because of the presence of a few drops of oil in it. It is already known to us that oil has high turbidity values and hence for this reason a very small quantity of oil is added in the third sample. Thus as expected because of the presence of soap the pH comes out to be in the alkaline range of 8.8 while because of the presence of oil the turbidity also increases compared to plain drinking water and comes out to be 50NTU.

Table 5: Readings observed consequently for 4 days at a particular time (i.e. 5 p.m. in this case.)

Day of the week	Temperature (in Degree Celsius)	pH	Turbidity (in NTU)
Tuesday	21.2	8.4	91
Wednesday	22	7.9	100
Thursday	21.6	8.3	105
Friday	20	8.6	101

As seen in Table 5 readings for temperature, pH and turbidity have been observed for consecutive 4 days of a week at a particular time (i.e. 5 p.m. in this case) and it is observed that all the three parameters have nearby values in and around all the 4 days of the week. It is also observed that the water body under study has an alkaline nature since the pH is more than 7 in all the 4 cases. The water quality is also quite turbid since the turbidity values are quite high for all the 4 cases.

Temperature is that parameter that directly gives the measure of dissolved oxygen in water. Less the temperature more is the presence of oxygen in water and vice versa is the other case. Higher temperature also provides higher chances of the water being infected by harmful pathogens like bacteria and viruses. pH also gives a direct measure of survival of fish fauna in around an area because different kinds of fishes can survive only within a certain range of pH values only. Any value beyond or less than that is a threat to their survival. Turbidity is a measure of dissolved components in a sample of water or in other words a measure of cloudiness in water. Turbidity directly affects those organisms that are directly dependent on light for carrying out photosynthesis (i.e. Aquatic plants). An effect on them has an immediate effect on those aquatic organisms that depend on these plants for their food and similarly the entire aquatic food chain is affected by a simple change of turbidity value.

5. FUTURE WORK

The overall system can become even more effective if we receive the data from the sensors remotely without any manual intervention [12-14] .Thus concepts of remote sensing can be applied to enhance the overall performance of the system where data can be received from the sensors at any place and time as and when required by the user [13]. Future developments can be made by introducing a GSM Module at the end of the microcontroller and then displaying the results on the LCD. Using the GSM Module the registered user can continuously update oneself with the present status of the sensor values and monitor the given water body more efficiently without being physically present at site. Threshold values can be set for the different water quality monitoring parameters like temperature, pH, turbidity as seen in Table 2 and condition the program code in Arduino such that whenever the upper and lower limits of the threshold values are crossed an sms alert is sent to the registered mobile number and can thus take steps accordingly to nullify the effects produced in the water body and safeguard the aquatic life of the given water body. The system performance can further be enhanced by constructing similar nodal systems and positioning them across a larger water body at certain specific interval so that the system can be used for monitoring even larger water bodies compared to smaller fisheries or aquaculture ponds.

6. CONCLUSION

In this work, a microcontroller based system is designed which monitors the temperature, pH level and turbidity of a water body to check whether the water is suitable for fish breeding. If the quality of water so tested becomes unsuitable for fish breeding consequent steps can be taken to avoid any further damage to the quality of water. Aquatic plants and animals are on the first list which is directly affected by the drastic changes in water quality. Thus monitoring their growth and survival rates can be an indirect indication on how various parameters effecting water quality (i.e. temperature, pH, turbidity) are changing with time.

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